

**FRENCH RIVER BASIN
DUDLEY, MASSACHUSETTS**

**LOWER MERINO POND DAM
MA 00109**

**PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM**

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**DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
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PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA00109

Name of Dam: Lower Merino Pond

Town: Dudley

County and State: Worcester County, Massachusetts

Stream: Tributary of the French River

Date of Inspection: August 29, 1978

Lower Merino Pond Dam is a stone wall-earth dam which was originally built in about the 1850's. The dam has a maximum height of 21 feet and is approximately 338 feet long including the spillway. The spillway consists of a broad-crested weir and is constructed of masonry with a concrete cap and sidewalls. Normal discharge is over the weir, and along a natural channel to a culvert under Schofield Avenue.

The spillway, which is 33.7 feet long, includes remnants of a footbridge. Flashboards are rigidly mounted on the spillway. There are two intakes and one outlet at the dam. An intake and outlet are abandoned, while a second intake provides water for fire protection at the mills.

Due to its age, Lower Merino Pond Dam was neither designed nor constructed according to current approved state-of-the-art procedures. Based upon the visual inspection at the site, the limited engineering data, and little evidence of operational or maintenance procedures, it was concluded that there were deficiencies that must be corrected to assure the continued performance of this dam. Generally, Lower Merino Pond Dam is considered to be in poor condition. Because of the potential danger to lives and property downstream Lower Merino Pond Dam has been classified as a "high" hazard.

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The principal areas of concern are: seepage in the stone masonry abutments at the spillway and in areas along the toe; abandoned, blocked but leaking outlet; fractures along the downstream masonry wall; erosion behind spillway side walls; deteriorated concrete at the spillway walls; apparent surface depressions over the abandoned outlet to the wheel house; thick vegetation along the crest of the dam; and seepage under the concrete weir cap.

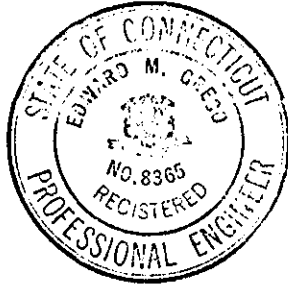
Hydraulic analyses indicate that the spillway can discharge a flow of 260 cubic feet per second (cfs) with the water surface at elevation (El) 472.9, which is the lowest elevation on the crest of the dam. An outflow test flood of 2,900 cfs (one-half the probable maximum flood) will overtop the dam by about 2.3 feet. The spillway is inadequate since it can discharge only 9 percent of the test flood before the dam is overtopped. In the event of overtopping, complete failure of the dam could occur. Because of the potential for overtopping, it is recommended that a definite plan for surveillance and a warning system be developed for use during periods of unusually heavy rains and/or runoff. The warning system should be coordinated with other warning systems required at the upstream reservoirs in the drainage area.

It is recommended that the Owner employ a qualified consultant to evaluate the stability of the dam, conduct a more detailed hydrologic and hydraulic investigation, evaluate the seepage in the stone spillway abutments and other areas, evaluate the fracturing of the downstream masonry block walls, investigate the source of leakage at the outlet, and provide a suitable outlet for lowering the pond. It is also recommended that the Owner repair the spillway sidewalls, erosion and sloughing of the crest, and the leakage at the outlet; remove the footbridge and flashboard support structure; provide riprap protection; and remove all trees from the crest of the dam. The Owner should also implement a systematic program of inspection and maintenance.

The recommendations and remedial measures described in Section 7 should be implemented by the Owner within a period of one year from receipt of this Phase I Inspection Report. An alternative to these

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recommendations would be draining the pond and breaching or removing the dam.



A handwritten signature in cursive script, reading "Edward M. Greco".

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LOWER MERINO POND DAM

This Phase I Inspection Report on Lower Merino Pond Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice and is hereby submitted for approval.

CHARLES G. TIERSCH, Chairman
Chief, Foundation and
Materials Branch
Engineering Division

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

SAUL C. COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

LOWER MERINO POND DAM

PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for a Phase I Investigation. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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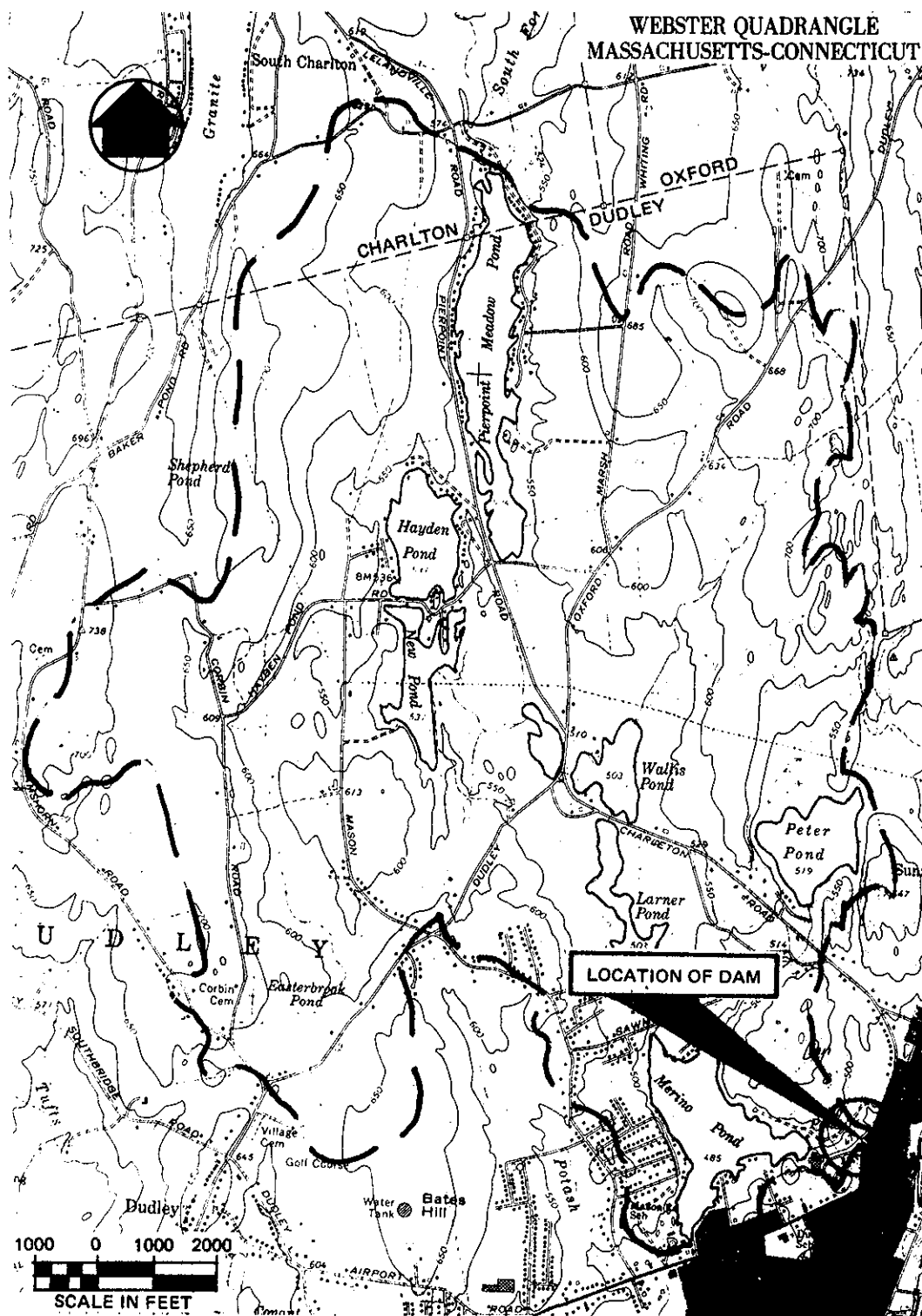
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**OVERVIEW
LOWER MERINO POND DAM
DUDLEY, MASSACHUSETTS**



VIEW FROM UPSTREAM OF DAM

**Location and Direction of Photographs
Shown on Figure in Appendix B**



LOCATION MAP - LOWER MERINO POND DAM

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SECTION 1

PROJECT INFORMATION

1.1 General

- a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Metcalf & Eddy, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued to Metcalf & Eddy, Inc. under a letter of July 28, 1978, from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW 33-78-C-0306 has been assigned by the Corps of Engineers for this work.
- b. Purpose:
 - (1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
 - (2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.
 - (3) Update, verify and complete the National Inventory of Dams.

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1.2 Description of Project

- a. Location. The dam is located in the Town of Dudley, Worcester County, Massachusetts, on an unnamed tributary of the French River. Lower Merino Pond is immediately downstream of Merino Pond (see Location Map).
- b. Description of Dam and Appurtenances. The dam at Lower Merino Pond was apparently constructed during the mid-1800's adjacent to the Stevens Linen Mill. Previously water from the pond had been used to provide power to the mill. Currently, the water is used to provide fire protection. A plan and section of the dam is shown in Appendix B, Figure B-1. The dam consists of a dry stone masonry wall with earth fill. The stone wall has a slight outward batter and is a maximum of 21 feet high at the spillway. The stone wall, excluding the spillway section, is about 304 feet long and has two distinct horizontal bends in alignment. The dam abuts natural ground at the north end and the "old wheel house" at the southeastern end. The top of the earth fill, which is also the crest of the dam, varies from about El 473 to El 474 feet. The top width varies from 15 feet at the southeastern end to 22 feet to 31 feet along the remainder of the dam.

The spillway consists of a concrete-faced broad-crested weir. The spillway is 33.7 feet long. The stone wall face of the spillway is similar to that of the dam.

Concrete side walls approximately 3 feet high at the spillway retain the earth fill. The steel superstructure of an old foot bridge - rigidly supports removable flashboards, some of which were in place during the field investigation.

Water flowing over the spillway drops vertically to the streambed below. The streambed at the dam consists of a rock outcrop.

An earthen dike extends from the southeastern abutment of the dam and along the southern edge of the pond. The dike is approximately 345 feet long and about 3 feet high. The first 95 feet of dike, closest to the dam, consists of earth fill abutting a section of the mill building. The remaining section consists of earth fill having grassed downstream slopes. Several residences are immediately downstream of the dike.

None of the upstream slopes along the dike or dam have riprap protection.

Two intakes and one outlet have been constructed at the dam. An intake and outlet are abandoned while the second intake remains operative and provides water for fire protection at the mill according to the Owner. One of the abandoned intakes provided water to power the wheel in the wheelhouse (Intake A, Figure B-1). The intake has since been abandoned, partially removed and filled-in with earth. The second intake, a drop inlet (Intake B, Figure B-1) is located along the dike near the mill buildings. According to the Owner, water from this intake is piped to a pumping station at the mill where it is used for fire protection. The outlet (Figure B-1), which is located near the north end of the dam, is the outlet for the pond and has been abandoned. The top of the outlet structure is visible beneath the water. The opening has apparently been blocked and there is no evidence of a gate or operating mechanism. The outlet is a 2-foot by 2-foot opening in the downstream wall.

A small diameter pipe is visible on the bottom of the pond connecting from Upper Merino Pond Dam to the plant. According to the owner it terminates within the wheel house and serves no purpose at this time.

- c. Size Classification. Lower Merino Pond Dam is classified in the "small" size category since it has a maximum height of 21 feet and a maximum storage capacity of 85 acre-feet.

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- d. Hazard Classification. Immediately downstream of the dam across Schofield Avenue are several buildings of the Stevens Linen Associates. A failure of the dam could pose a threat to human life in the mill buildings. Numerous residences and businesses are also located downstream of the mill. A power transmission line also crosses the stream downstream of the pond. Several residences are also located along the southern edge of the pond adjacent to the dike. Based on the above, the dam is placed in the "high" hazard category.
- e. Ownership. The dam is presently owned by the Stevens Linen Company, P. O. Box 220, Webster, Massachusetts. Mr. Robert Javery of Stevens Linen Company (617-943-0600) granted permission to enter the property and inspect the dam.
- f. Operator. The Stevens Linen Company operates the fire control intake and are the only operators of the dam.
- g. Purpose of the Dam. The dam at Lower Merino Pond was constructed to provide process water and power at the mill. According to the Owner it is now used to provide water for fire protection at the mill.
- h. Design and Construction History. There is no information available on the design or construction of the dam. Review of previous inspection reports and other written information available at the Worcester County Engineers Office helped formulate a brief construction history.

Information indicates that the dam was constructed sometime during the 1850's. Some inspection reports, dating back to 1926, point out conditions that required repair. In 1930, for instance, slight seepage was noted on the downstream wall and the "gate timber" required replacement.

Generally, the leaks that had been noted focused on the gate structures, presumably the two that are presently abandoned. In

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1937, after the storm of March, 1936 some damage occurred to the masonry spillway crest and leaks around the gate were observed. Apparently by 1938 some repairs to the dam were completed. Subsequent inspection reports note that the condition of the dam was satisfactory. Between 1947 and 1950 new gates were apparently installed although slight leakage was noted. The flood of 1955 caused no damage that required repairs. Overtopping of the dike was reported by a local resident.

A diagram of the dam from a 1939 inspection report shows a trash rack and walkway built across the pond, presumably near the location of the concrete intake for fire protection. The walkway and trash rack no longer exist.

Based on 1947 and 1950 inspection reports, recommendations were made by the Worcester County Engineers office to increase the capacity of the spillway. However, these recommendations were apparently never initiated.

1. Normal Operating Procedure. There are no operating procedures at the dam. Flow over the spillway is uncontrolled. The only operating outlet is through the fire protection system.

1.3 Pertinent Data

- a. Drainage Area. The drainage area for Lower Merino Pond is estimated to be 3,675 acres (5.74 square miles). The area includes the watersheds for: Pierpoint Meadow Pond, Hayden Pond, New Pond, Wallis Pond, Easterbrook Pond, Larner Pond, Peter Pond, Upper and Lower Merino Pond, as well as minor un-named ponds within the watershed.
- b. Discharge at the Dam Site. Uncontrolled discharge at the dam site flows over a 33.7-foot long weir and drops vertically to the streambed below and is then directed through a stone masonry arch beneath Schofield Avenue. The stream bed consists of exposed bedrock

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near the dam. Flow has cut a steep channel where it abuts the mill. Discharge through the blocked but leaking 2-foot by 2-foot outlet in the downstream face of the dam eventually flows to the stream at the culvert under Schofield Avenue.

Hydraulic analyses indicate that the spillway can discharge an estimated 260 cfs with the water surface at El 472.9, which is the lowest point on the crest of the dam.

An inflow test flood of 3,300 cfs (one-half the probable maximum flood) adjusted for surcharge storage results in a maximum discharge of 2,900 cfs. This outflow will overtop the crest of the dam by about 2.3 feet.

- c. Elevation (feet above MSL (Mean Sea Level)).
A benchmark was established at El 471.0 on the crest of the spillway. This elevation was estimated from a United States Geological Survey (USGS) topographic map.
- (1) Top main dam: 472.9 to 474.5
Top dike: 474.1 to 474.8
 - (2) Test flood pool: 475.3.
 - (3) Design surcharge (original design):
unknown
 - (4) Full flood control pool: N/A
 - (5) Recreation pool: 471.0 (without flashboards)
 - (6) Spillway crest (ungated): 471.0 to 471.1
 - (7) Upstream portal invert diversion tunnel:
N/A
 - (8) Streambed at spillway of dam: 453.4
(assumed water discharging over spillway)
 - (9) Tailwater: N/A

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d. Reservoir

- (1) Length of maximum pool: 1,000 feet
- (2) Length of recreation pool: 1,000 feet
- (3) Length of flood control pool: N/A

e. Storage (acre-feet)

- (1) Test flood surcharge: 21.5 at El 475.3
- (2) Top of dam: 85 at El 472.9
- (3) Flood control pool: N/A
- (4) Recreation pool: 75 (Approximate)
- (5) Spillway crest: 75

f. Reservoir Surface (acres)

- *(1) Top dam: 5
- *(2) Test flood pool: 5
- (3) Flood-control pool: N/A
- (4) Recreation pool: 5
- (5) Spillway crest: 5

g. Dam

- (1) Type: stone wall - earth
- (2) Length: 338 feet
- (3) Height: (maximum) 21 feet
- (4) Top width: 15 to 31 feet
- (5) Side slopes: Upstream, variable by erosion, approximately 1-1/2:1
Downstream vertical (with slight batter)

*Based on the assumption that the surface area will not significantly increase with changes in pond elevation from 471.0 to 475.3.

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- (6) Zoning: Unknown
- (7) Impervious core: Unknown
- (8) Cutoff: Unknown
- (9) Grout curtain: Unknown

i. Spillway

- (1) Type: broad crest
- (2) Crest length: 33.7 feet
- (3) Crest elevation: 471.0 (assumed benchmark)
- (4) Gates: None operable
- (5) Upstream channel: earthen slope
- (6) Downstream channel: Natural streambed, heavily vegetated

j. Regulating Outlets. The only regulating outlet at this dam is the intake used to provide fire protection at the mill. The drop inlet-type intake was gated.

SECTION 2

ENGINEERING DATA

- 2.1 General. There are no drawings available for Lower Merino Pond Dam. Visual observations during inspection, review of previous inspection reports, and conversations with the Owner and with personnel from Town, State and County agencies provided the data for this evaluation.

We acknowledge the assistance and cooperation of personnel of the Massachusetts Department of Public Works, Messrs. Willis Regan and Raymond Rochford, and personnel of the Massachusetts Department of Environmental Quality Engineering, Division of Waterways, Messrs. John J. Hannon and Joseph Iagallo.

Also, we acknowledge the cooperation and assistance of personnel from the Worcester County Engineer's Office, Messrs. John O'Toole, and Joseph Brazauskas.

Mr. Robert Javery granted permission to enter the property and inspect the dam.

- 2.2 Construction Records. There are no as-built drawings or construction records for the dam.
- 2.3 Operation Records. No operating records are available for the dam and no daily record is kept of the elevation of the pool or rainfall at the dam site.
- 2.4 Evaluation
- a. Availability. Due to the age of this dam, there is limited engineering data available.
 - b. Adequacy. The lack of indepth engineering data did not allow for a definitive review. Therefore the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, history of past performance and engineering judgment.

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- c. Validity. Comparison of available information with the field survey conducted during the Phase I inspection indicates that the information is valid.

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SECTION 3
VISUAL INSPECTION

3.1 Findings

- a. General. The Phase I Inspection of the dam at Lower Merino Pond was performed on August 29, 1978. A copy of the inspection check list is in Appendix A. Periodic inspections of this dam have been made by others since 1926. A partial listing of these inspections is in Appendix B. An inspection by the Massachusetts Department of Public Works was made in 1972, and a copy of that report is also included in Appendix B. In addition, early inspection reports were reviewed at the Worcester County Engineer's office.
- b. Dam. The dam is in poor condition. The crest is heavily overgrown with trees and brush. The vertical stone masonry wall appeared in satisfactory condition although some vertical fractures were noted in the lower masonry blocks. The fractures are prevalent within the lower third of the dam and are of concern. One smaller stone filling a void appeared crushed and many others are missing. The upstream slopes were eroded near the crest. One tree was observed growing within the face of the spillway abutment wall. Otherwise, the wall was free of vegetation. Several leaks were noted at the face of the wall and the locations are shown in Figure B-1 of Appendix B. A large seepage zone was noted at the northwest spillway abutment extending from the spillway about 5 feet near the top of the downstream wall to about 10 feet at the bottom. A very small seepage area was noted about 110 feet from the northwest spillway abutment at the lower part of the downstream wall. A small area in front of the toe of the downstream wall about 45 feet from the northwest spillway abutment appeared to be leaking. Fill over this area covered the toe of the wall. A seepage area was noted along the toe of the south spillway abutment and abutment to the mill building.

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- c. Appurtenant Structures. The concrete of the spillway weir and sidewalls is in fair condition. The most noticeable deficiency occurs at the sidewalls where the fill has been eroded from behind the walls on each side of the spillway. There, the concrete is badly spalled. Several cracks were evident in the concrete weir. The flashboards on the spillway leaked between the bottom of flashboard and spillway weir. The flashboards are rigidly supported by a footbridge superstructure. It did not appear to be an easy task to remove the flashboards during flood flows, nor did it appear that the boards themselves would fail during high overtopping flows. The downstream wall at the spillway leaked in several areas near the top, most noticeably between the concrete cap and top of the masonry blocks. The downstream channel was cluttered with large logs and other debris.

The intakes were previously described in Section 1.2.c. Intake A has been abandoned and filled, although some parts are still visible. Intake B appeared in good shape. It consisted of a concrete box about 5 feet by 7 feet in area. The inlet was provided with a trash rack to protect it from trash and the top of the box had a metal cover in good condition. The elevation of the inlet could not be determined. The outlet, also abandoned, has been blocked but leaks. No information is available on how the intake is blocked. About 4 inches of water was noted discharging from the box conduit opening at the downstream wall. The outlet structure is completely submerged as was not visible for inspection.

A submerged pipe was visible in the pond near the spillway. The Owner indicated the pipe was ungated but blocked and it terminated in the old wheelhouse. The Owner also stated that the pipe was leaking into the buildings.

- d. Reservoir Area. Areas south of the pond and dam are heavily populated and consist of residences and sections of downtown Webster.

Areas north of the pond are sparsely populated and are generally above pond level. At

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least two residences and part of the mill are adjacent to the dike and dam and the Stevens. Linen Company Mill is immediately downstream.

- e. Downstream Channel. The discharge from the spillway follows a natural streambed which abuts a section of the mill. It passes under Schofield Avenue through a 14.5-foot wide by 5-foot high masonry arched culvert and eventually into the French River which passes through downtown Webster. The downstream area between the dam and Schofield Avenue slopes from El. 453 at the dam to El. 433 at the invert of the arched culvert. The distance is approximately 300 feet. The area is wooded near the dam and grassed with tall weeds near the roadway. A power line crosses the stream downstream of the pond.

- 3.2 Evaluation. The above findings indicate that the dam has several areas of distress that require immediate attention. It is evident that the dam is not maintained and that deterioration will continue unless action is taken. Recommended measures to improve the conditions are included in Section 7.

SECTION 4
OPERATING PROCEDURES

- 4.1 Procedures. There are no operating procedures at Lower Merino Pond Dam.
- 4.2 Maintenance of Dam. There is no maintenance program at the dam. However, the dam is visited frequently as the Steven's Linen Company is adjacent to the dam.
- 4.3 Maintenance of Operating Facilities. Two of the outlet structures are closed and have been abandoned. A third outlet is used to provide water for fire protection. Flow over the spillway is controlled only by flashboards.
- 4.4 Description of Any Warning System in Effect. There is no warning system in effect at the dam.
- 4.5 Evaluation. Lower Merino Pond Dam is in poor condition and has been placed in the "high" hazard category because of the possible danger to life and property downstream and damage to a power line. For this reason, it is important that procedures for operation, maintenance, and emergencies be implemented as recommended in Section 7.

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SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

- a. Design Data. The Probable Maximum Flood (PMF) rate was determined to be 1,150 cfs per square mile. This calculation is based on the average drainage area slope of 2.4 percent, the pond-plus-swamp area to drainage area ratio of 13 percent, and the U. S. Army Corps of Engineers' guide curves for Maximum Probable Flood Peak Flow Rates (dated December 1977). Applying one-half the PMF to the 5.74 square miles of drainage area results in a calculated peak flood flow of 3,300 cfs as the inflow test flood. By adjusting the inflow test flood for surcharge storage, the maximum discharge rate was established as 2,900 cfs (505 cfs per square mile), with a water surface at El 475.3.

Flow over the crest of the dam is predicted to be 2,050 cfs. Flow through the main spillway (assuming flashboards have been removed) would be 850 cfs. The maximum depth on the crest of the dam would be 2.3 feet with a discharge of 9.3 cfs per foot of width. Depth at critical flow would be at 1.4 feet with a velocity of 6.7 feet per second.

Hydraulic analyses indicate that the existing spillway can discharge 260 cfs with the water surface at El 472.9.

- b. Experience Data. Hydraulic records are not available for this dam, however, information supplied by a resident indicated that overflow occurred at the dike during the 1950's. The Owner indicated that the dam has not been overtopped during floods.
- c. Visual Observations. Discharge from Lower Merino Pond is over a broad crested weir spillway. The spillway has a concrete cap under which considerable flow was discharging. Although the concrete crest and sidewalls appeared sound, except as noted in Section 3,

LOWER MERINO POND DAM

it is not properly connected to the dam structure. A more detailed record of observation is included in Section 3, Visual Inspection.

- d. Overtopping Potential. Overtopping of the dam by about 2.3 feet is expected under the outflow test flood of 2,900 cfs. In the event of overtopping, complete failure of the dam could occur.

Failure of the dam would produce a peak discharge of 9,100 cfs and a flood wave 8.0 feet high. The channel is too short between the dam and roadway and occupied structures to allow any channel attenuation of the initial surge wave. Discharge from the dam passes under Schofield Avenue via a 5-foot by 14.5-foot arched culvert.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

- a. Visual Observations. The evaluation of the structural stability of the dam is based on the visual inspection conducted on August 29, 1978.

Based on the observations as discussed in Section 3, Visual Inspection, and on the evaluation of the hydraulic computations, the dam at Lower Merino Pond is considered to be a hazard. The condition of the dam is unsatisfactory.

It is recommended that a more detailed investigation be initiated immediately to evaluate the stability of the dam and the seepage along the face of the downstream wall and at the abandoned outlet. The severe leaking near the spillway is apparently more recent than 1972. The fractures in the masonry blocks should also be investigated immediately.

- b. Design and Construction Data. Discussions with the Owner, County and State personnel indicate that there are no available plans, specifications, or computations on the design, construction, or repair of the dam. Information on the type, shear strength and permeability of the soil and/or rock materials is nonexistent.

Previous inspection reports indicate that sections of the spillway damaged in the March 1936 flood as well as leaks through the downstream wall were repaired. Subsequent reports indicated that the condition of the dam was satisfactory.

- c. Operating Records. There is no evidence that any type of instrumentation had ever existed at Lower Merino Pond Dam. The performance of the spillway and dam under prior loading can only be inferred from physical evidence at the site.

LOWER MERINO POND DAM

- d. Post-construction Changes. In the past repairs have been made at the spillway and gates as indicated in this report and in past inspection reports.
- e. Seismic Stability. The dam is located in Seismic Zone No. 2 and in accordance with Phase I "Recommended Guidelines" does not warrant seismic analyses.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

- a. Condition. Built about 1850, Lower Merino Pond Dam was neither designed nor constructed according to current approved state-of-the-art procedures. Based upon the visual inspection, limited engineering data, and little evidence of operation or maintenance, it is determined that various conditions must be corrected to assure the continued performance of this dam. Generally, the dam is considered to be in poor condition. The principal areas of concern are: seepage in the stone masonry abutments at the spillway and in areas along the toe; abandoned, blocked outlet conduit which leaks; fractures along the downstream masonry wall; washout behind spillway side walls; deteriorated concrete at the walls; seepage under the concrete weir; apparent surface depressions over the abandoned outlet to the wheel house; and thick vegetation along the crest of the dam.

Hydraulic analyses indicate that the existing spillway can discharge a flow of 260 cfs with the water surface of the pond at El 472.9, which is the low point on the dam. The spillway may be inadequate since it can discharge only 9 percent of the test flood before the dam is overtopped. An inflow test flood of 3,300 cfs will overtop the dam by 2.3 feet. A detailed hydraulic analysis of the dam and entire watershed including upstream dams would alter these results.

- b. Adequacy of Information. The lack of indepth engineering data did not allow for a definitive review. Therefore the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and engineering judgment.

LOWER MERINO POND DAM

- c. Urgency. The recommendations outlined below should be implemented by the Owner within one year after receipt of this Phase I Inspection Report.
- d. Need for Additional Investigation. Additional investigations to further assess the adequacy of the dam and spillway are outlined below in Section 7.2, Recommendations.

7.2 Recommendations. In view of the concerns over the continued performance of the dam and spillway, it is recommended that the Owner employ a qualified consultant to:

- a. evaluate the stability of the dam
- b. conduct a more detailed hydrologic and hydraulic investigation of the site to determine the actual impact of the watershed and upstream dams on Lower Merino Pond Dam, and evaluate the need for increased spillway capacity.
- c. investigate the cause of fracturing of the masonry blocks along the downstream wall
- d. investigate the seepage at the dam and the erosion and sloughing along the crest.
- e. investigate the source of leakage at the outlet and the adequacy of the seal.
- f. determine and design a suitable outlet for lowering the pond.

The recommendations on repairs and maintenance procedures are outlined below under Section 7.3.

7.3 Remedial Measures

- a. Operating and Maintenance Procedures. The dam and spillway are not adequately maintained. It is recommended that the Owner accomplish the following:
 - (1) Install an operable gated outlet in addition to the outlet for fire protection.
 - (2) Adequately seal or remove the leaking pipe leading to the wheel house.

LOWER MERINO POND DAM

- (3) Repair both the washout area behind the side walls and surface depression over the abandoned outlet to the wheel house.
- (4) Remove all trees and brush from the crest of the dam, and clear debris for the downstream spillway area.
- (5) Repair the leaking abandoned outlet at the northwest end of the dam.
- (6) Remove the footbridge structure and flashboards.
- (7) Provide riprap protection on the upstream face of the dam.
- (8) Institute a definite plan for surveillance and a warning system during periods of unusually heavy rains and/or runoff. The warning system should be coordinated with one at the upstream reservoirs in the watershed, because flooding or failure of the upper dams will have a severe effect on Lower Merino Pond Dam.
- (9) Implement a systematic program of maintenance inspections. As a minimum, the inspection program should consist of a monthly inspection of the dam and appurtenances and be supplemented by additional inspections during and after severe storms. All repairs and maintenance should be undertaken in compliance with all applicable State regulations.
- (10) Technical inspections of this dam should be conducted annually.

7.4 Alternatives. An alternative to implementing the recommendations and remedial measures listed above would be to drain the pond and breach or remove the dam.

APPENDIX A
PERIODIC INSPECTION
CHECKLIST

LOWER MERINO POND DAM

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT Lower Merino Pond

DATE August 29, 1978

TIME 8:00 A.M. - 2:30 P.M.

WEATHER Hazy and Humid

W.S. ELEV. 471* U.S. DN.S.

*Assumed benchmark top
of spillway weir

PARTY:

- | | |
|--------------------|--------------------------------|
| 1. <u>R. Weber</u> | 6. <u>L. Branagan</u> |
| 2. <u>W. Diesl</u> | 7. <u> </u> |
| 3. <u>H. Lord</u> | 8. <u> </u> |
| 4. <u>D. Cole</u> | 9. <u> </u> |
| 5. <u>E. Greco</u> | 10. <u> </u> |

PROJECT FEATURE	INSPECTED BY	REMARKS
1. <u>Dam/Embankment</u>	<u>Weber - Greco</u>	
2. <u>Spillway/Outlet Structures</u>	<u>Weber - Branagan</u>	
3. <u> </u>		
4. <u> </u>		
5. <u> </u>		
6. <u> </u>		
7. <u> </u>		
8. <u> </u>		
9. <u> </u>		
10. <u> </u>		

PERIODIC INSPECTION CHECK LIST

PROJECT Lower Merino Pond DATE August 29, 1978
 PROJECT FEATURE Dam NAME Weber
 DISCIPLINE Geotechnical NAME Greco

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	
Crest Elevation	472.9 to 474.5 Heavy vegetation
Current Pool Elevation	471
Maximum Impoundment to Date	Unknown
Surface Cracks	None visible - crest irregular higher at upstream end
Pavement Condition	N/A
Movement or Settlement of Crest	irregular crest fill and/or erosion
Lateral Movement	None apparent
Vertical Alignment	Approximately horizontal
Horizontal Alignment	Curved
Condition at Abutment and at Concrete Structures	} good at abutment of dam and nat. ground at spillway - erosion at side walls at abutment of bldg. - sloughing over old in-take channels
Indications of Movement of Structural Items on Slopes	
Trespassing on Slopes	N/A
Sloughing or Erosion of Slopes or Abutments	Foot path
Rock Slope Protection - Riprap Failures	Erosion of upstream earth fill No slope protection apparent
Unusual Movement or Cracking at or near Toes	N/A
Unusual Embankment or Downstream Seepage	} Lower third of downstream vert. masonry wall, north of spillway shows fractures
Piping or Boils	
Foundation Drainage Features	Discharge through blocked outlet, seepage at north abutment to spillway seepage as shown on plan
Toe Drains	None visible
Instrumentation System	Unknown
	Unknown
	None visible

PERIODIC INSPECTION CHECK LIST

PROJECT Lower Merino Pond

PROJECT FEATURE Dike Embankment

DISCIPLINE Geotechnical

DATE August 29, 1978

NAME Weber

NAME Greco

AREA EVALUATED	CONDITION
<u>DIKE EMBANKMENT</u>	
Crest Elevation	474.1 to 474.8
Current Pool Elevation	471
Maximum Impoundment to Date	Unknown
Surface Cracks	None visible
Pavement Condition	N/A
Movement or Settlement of Crest	None visible
Lateral Movement	None visible
Vertical Alignment	Approximately horizontal
Horizontal Alignment	Straight
Condition at Abutment and at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	N/A
Trespassing on Slopes	Residence at toe of dike
Sloughing or Erosion of Slopes or Abutments	{Upstream erosion, no protection visible
Rock Slope Protection - Riprap Failures	N/A
Unusual Movement or Cracking at or near Toes	None visible
Unusual Embankment or Downstream Seepage	None visible
Piping or Boils	None visible
Foundation Drainage Features	UNK
Toe Drains	UNK
Instrumentation System	UNK

PERIODIC INSPECTION CHECK LIST

PROJECT Lower Merino Pond DATE August 29, 1978
 PROJECT FEATURE Spillway NAME Weber
 DISCIPLINE Geotechnical NAME Branagan

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	
a. Approach Channel	Gravel bottom
General Condition	{ Fair - earth slopes and concrete side walls
Loose Rock Overhanging Channel	
	None visible
Trees Overhanging Channel	No
Floor of Approach Channel	Not visible
b. Weir and Training Walls	Concrete walls - concrete weir
General Condition of Concrete	{ Fair to poor - erosion behind wall, reveal cavitation, spalling of concrete surface, cavitation and erosion of weir
Rust or Staining	
Spalling	None
	Slight along edge at spillway
Any Visible Reinforcing	No
Any Seepage or Efflorescence	Seepage behind walls apparent where embankment eroded
Drain Holes	None visible
c. Discharge Channel	
General Condition	Fair - cluttered with debris
Loose Rock Overhanging Channel	No
Trees Overhanging Channel	Vegetation within sides of channel
Floor of Channel	Cut to bedrock
Other Obstructions	None

PERIODIC INSPECTION CHECK LIST

PROJECT Lower Merino DATE August 29, 1978
 PROJECT FEATURE _____ NAME Weber
 DISCIPLINE Geotechnical NAME Branagan

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u>	Intake A (Abandoned)
a. Approach Channel	Inlet blocked
Slope Conditions	N/A
Bottom Conditions	N/A
Rock Slides or Falls	N/A
Log Boom	N/A
Debris	Not visible
Condition of Concrete Lining	Concrete training walls leading to inlet
Drains or Weep Holes	N/A
b. Intake Structure	--
Condition of Concrete	Abandoned, inlet blocked
Stop Logs and Slots	N/A

PERIODIC INSPECTION CHECK LIST

PROJECT Lower Merino DATE August 29, 1978
 PROJECT FEATURE _____ NAME Weber
 DISCIPLINE Geotechnical NAME Branagan

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u>	Intake B (Fire Protection)
a. Approach Channel	Gravel bottom
Slope Conditions	Fair, gravel submerged,
Bottom Conditions	Gravel, cobbles
Rock Slides or Falls	N/A
Log Boom	N/A
Debris	Slight vegetation
Condition of Concrete Lining	N/A
Drains or Weep Holes	N/A
b. Intake Structure	Drop inlet
Condition of Concrete	Fair, slight cavitation at
Stop Logs and Slots	water line and below Fair, but rusted

PERIODIC INSPECTION CHECK LIST

PROJECT Lower Merino DATE August 29, 1978
 PROJECT FEATURE _____ NAME Weber
 DISCIPLINE Geotechnical NAME Branagan

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL</u>	
General Condition of Concrete	Not visible
Rust or Staining	-
Spalling	-
Erosion or Cavitation	-
Visible Reinforcing	-
Any Seepage or Efflorescence	{ Water leaking into outlet, discharge from a 2'x2' opening in downstream wall
Condition at Joints	
Drain Holes	-
Channel	-
Loose Rock or Trees Overhanging Channel	"
Condition of Discharge Channel	Vegetation covering channel

PERIODIC INSPECTION CHECK LIST

PROJECT Lower Merino Pond

DATE August 29, 1978

PROJECT FEATURE _____

NAME Weber

DISCIPLINE Geotechnical

NAME Branagan

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SERVICE BRIDGE</u>	
a. Super Structure	
Bearings	N/A
Anchor Bolts	--
Bridge Seat	--
Longitudinal Members	Steel flat irons
Under Side of Deck	--
Secondary Bracing	--
Deck	Missing
Drainage System	--
Railings	--
Expansion Joints	--
Paint	--
b. Abutment and Piers	--
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat and Backwall	

Note: Walkway missing - super structure poor condition
five bays

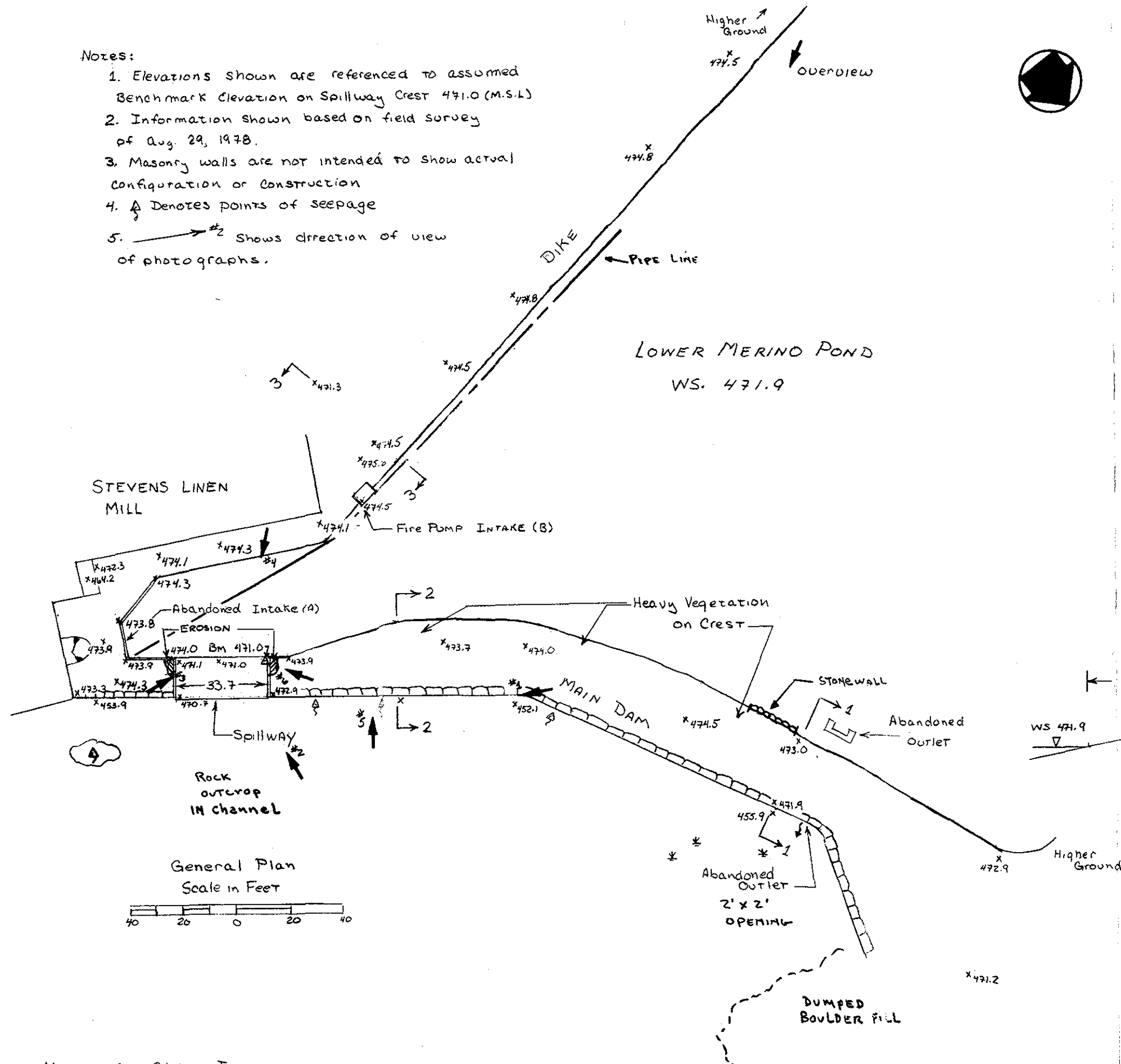
APPENDIX B

PLANS OF DAM AND PREVIOUS
INSPECTION REPORTS

	<u>Page</u>
Figure B-1, Plan of Dam and Sections	B-1
Previous Inspections (Partial Listing)	B-2
Inspection by Massachusetts Department of Public Works, dated January 10, 1972	B-3

Notes:

1. Elevations shown are referenced to assumed Benchmark Elevation on Spillway Crest 471.0 (M.S.L.)
2. Information shown based on field survey of Aug. 29, 1978.
3. Masonry walls are not intended to show actual configuration or construction
4. Δ Denotes points of seepage
5. \rightarrow #2 Shows direction of view of photographs.



Metcalf & Eddy, Inc.

METCALF & EDDY, INC. ENGINEERS BOSTON, MA.		U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WILMINGTON, MA.	
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS			
LOWER MERINO POND DAM			
FIGURE B-1 PLAN OF DAM AND SECTIONS			
TRIBUTARY FRENCH RIVER		MASSACHUSETTS	
SCALE: AS SHOWN		DATE: OCTOBER, 1978	

TOWN OR CITY	Dudley	DECREE NO.	MILL POND (M)	PLAN NO.	1936 Flood	DAM NO.	12-06
LOCATION	Webster- 1st pond below Merino Pond.			C. C. DOCKET NO.	80		
DESCRIPTION OF DAM				DESCRIPTION OF RESERVOIR & WATERSHED			
Type	1/8:1 dry wall - Earth- riprap El. 100'			Name of Main Stream	Small stream		
Length	350'			" " any other Streams	Hay Lake 2-12'		
Height	22'			Length of Watershed	40 R.		
Thickness top	27-30'			Width " "	20' + 2-15" 50 ft		
" bottom	50-60'			Is Watershed Cultivated	Letter 9/4/55		
Downstream Slope	1/8:1 wall			Percent in Forests			
Upstream "	1 1/2:1 riprap			Steepness of Slope			
Length of Spillway	El. 96.5 Depth = 3.5 Length = 33'			Kind of Soil	Ledge & Rocky Soil.		
Size of Gates	waste 2x2 opening El. 78.0			No. of Acres in Watershed	4.43 S. M.		
Location of Gates	60' south north end dam.			" " " Reservoir	20.		
Flashboards used	6" DOARDS El. 98.5 Yes			Length of Reservoir			
Width Flashboards or Gates	24"			Width " "			
Dam designed by				Max Flow Cu. Ft. per Sec.			
" constructed by				Head or Flashboards-Low Water			
Year constructed				" " " High	" 1938 Flood 2' over crest.		
GENERAL REMARKS				GENERAL REMARKS			
Owned by Stevens Limer Associates Inc. Merino Lower Pond Dam.				Inspected: March 20, 1936 - Finlayson & Vasselini.			
Inspected Jan. 7, 1925 - L.O. Marden				Dec. 6, '38 - Crawford says O.K.			
" Mar. 24, 1930 - " "				Inspected: 12-11-40 - W.O.L.			
" Dec. 11, 1931 - " "				" 12-30-41 - M. F. Hunt			
" July 27, 1932 - " Crawford & Healy				" 12-10-42 - J.A. Herholz			
" Jan. 13, 1937 - " Mast. Mach. Healy				" Jan. 21, 1944 - "			
Measured: Oct. 19, 1938 - E.S. Grover				" 12-11-45 KMF			
" Spill. Inspect: Mar. 23, 1939 - K.M. Finlayson.				" Dec. 1, 1947 - L.O.M.			
Inspected: Nov. 29, 1951 - L.H.S.				" 2, 1950 - "			

PREVIOUS INSPECTIONS (PARTIAL LISTING)

COPY OF INSPECTION CARD ON FILE AT THE MASSACHUSETTS
DEPARTMENT OF PUBLIC WORKS, DISTRICT OFFICE, WORCESTER.

INSPECTION REPORT & DATA FOR DAMS

Owner: STEVENS LINEN ASSOCIATES
His Address: MILL ST. DUDLEY
Function of Dam: MILL POND

Location & Access: WEBSTER 1ST POND BELOW MARINO POND

USGS Quad. Webster Lat. 42°02'55" Long. 71°53'28"
Drain. Ar.: 243 Sq. Mi. Ponds: ac. Res. @ dam: 20.00
Character of D.A.:

Dam No. 14-06

Town: DUDLEY

Stream: BROOK

Pond: LOWER MARINO POND

Date: 1/12/72

By:

CONDITION RATING

Structural: GOOD

Hydraulic: 35' X 5'

General: GOOD

PRIORITY: SHOULD CHECK

WASHOUT FREQUENTLY

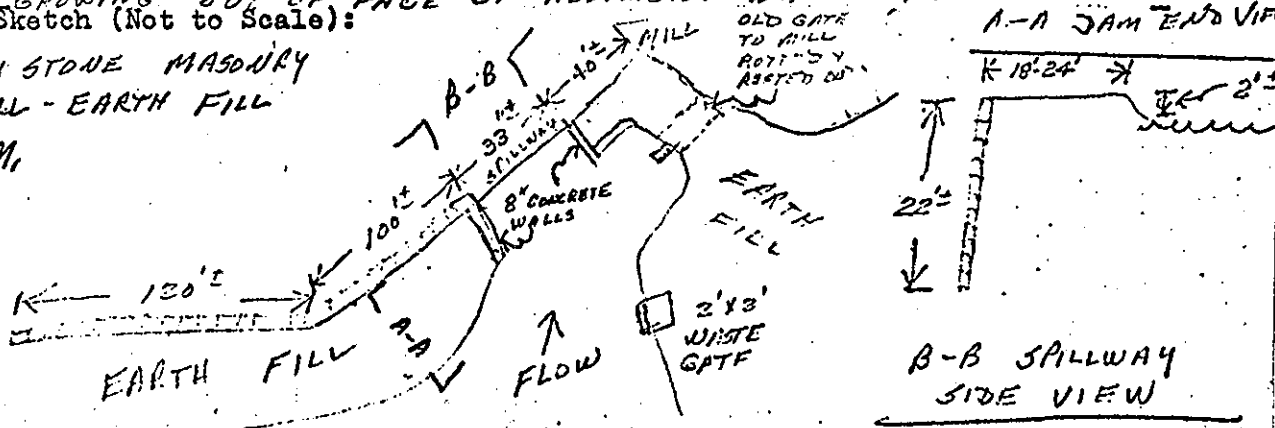
Estimated
Discharge:
Capacity:

General Description of Dam and Discharge Control: 1/2" 1 DR. WALL - EARTH

- RIPRAP SPILLWAY LEN. = 23' ± WASTE GATE 2' X 2'
- NUMEROUS MEDIUM LEAKS AT BASE OF DAM. NO APPARENT DANGER
- BRUSH TO 18" TREES GROWING ON TOP OF DAM. ONE 4" MAPLE GROWING OUT OF FACE OF ABUTMENT WALL

Sketch (Not to Scale):

DRY STONE MASONRY
WALL - EARTH FILL
DAM,



Remarks and Recommendations:

WASHOUT BEHIND WESTERLY WALL
AT SPILLWAY. SHOULD BE WATCHED.

6.5' LONG
1.5' WIDE
3.0' DEEP



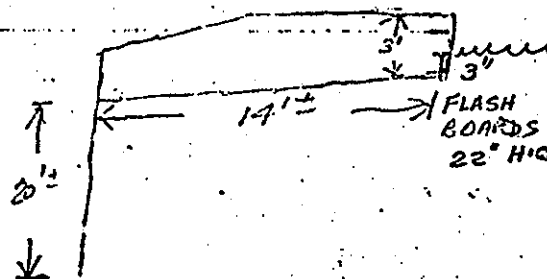
Date

1/10/72

By

VFP
28

Comment



Dam No. 14-06

APPENDIX C
PHOTOGRAPHS

LOWER MERINO POND DAM



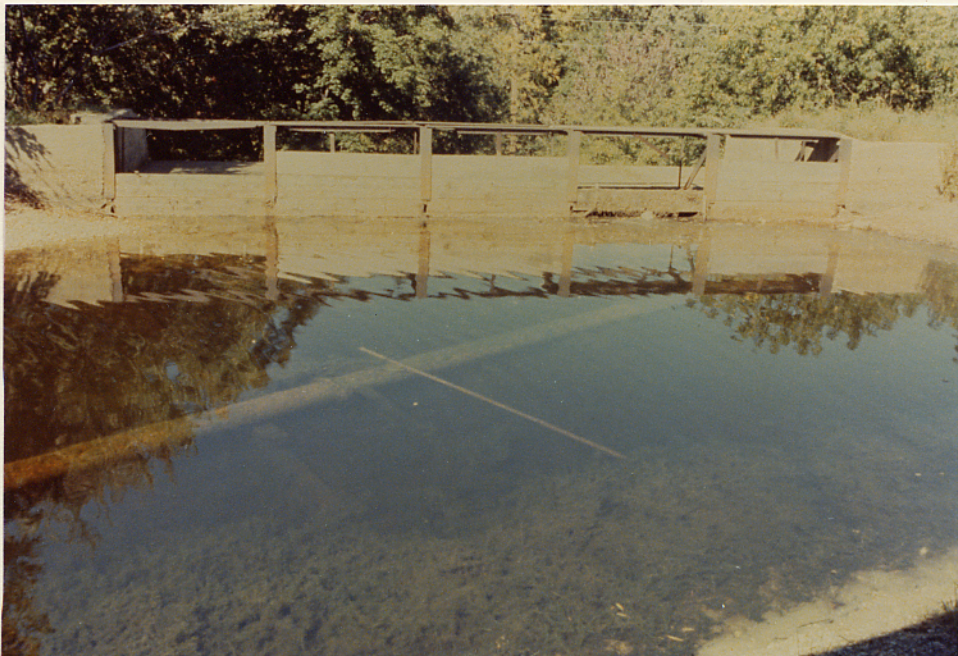
NO. 1 DOWNSTREAM STONE MASONRY WALL



NO. 2 LEAKAGE BENEATH SPILLWAY CREST



NO. 3 SPILLWAY CREST LOOKING UPSTREAM



NO. 4 PIPE IN SPILLWAY CHANNEL



NO. 5 FRACTURES IN DOWNSTREAM STONE MASONRY WALL



NO. 6 EROSION BEHIND SPILLWAY SIDEWALL

APPENDIX D
HYDROLOGIC AND HYDRAULIC
COMPUTATIONS

LOWER MERINO POND DAM

I Test Flood, 100 year storm & Storage Functions

1- Total Drainage Area - 5.74 mi²

2- Ponds & Swamps = .34 + .07 + .12 + .01 = 0.54 mi² Ponds
 = .13 + .04 + .02 = 0.19 " Swamps
 0.73 "

$$\% \text{ Ponds \& Swamps} = \frac{0.73}{5.74} = 13\%$$

3- 1.34% for 4.69 mi²; 5.3% for 0.39 mi²
 8.3% for 0.66 mi² } Say Ave Slope = 2.4% ✓

4- Using C. of E. Curves for Peak Flow Rates & above guide values the Peak Flow Rate was estimated to be closer to Flat & Coastal than Rolling, and taken at 1150 c.f.s./mi²

Due to low dam height use 1/2 MPF

5- Test Flood Inflow = $\frac{1}{2}(1150) 5.74 = 3300$ c.f.s.

6- Storage

A one foot rise increases storage as follows:

Lower Merino - 5 acre feet

Upper Merino - 77 acre feet

Both ponds have similar discharge characteristics & total storage effect of 82 ac. ft./ft is more characteristic

7- Storage Functions are based on $Q_{out} = Q_{in} [1 - \frac{S_{out}}{R}]$

S_{out} = Storage Vol. in Reservoir related to final Q_{out} in terms of inches of rain over the drainage area.

$$S(\text{in Inches}) = 12 D \left(\frac{.13}{5.74} \right)^* = 0.27 D; R = 6 \text{ hr rain of storm.}$$

D = Storage Depth (above spillway) on reservoir, in feet.

* Use Combined Area of Upper & Lower Merino - Similar Spill.-no channel

8- Storage Functions: (F_{TF}) ; D = 0 @ Elev. 471.0

$$F_{TF} = 3300 - 347 S = 3300 - 94 D$$

II Dam Discharge Operating Curves

A- Spillway (Assume flash board struct removed)

Width = 33.7', Use 33' for side contractions
 [Ref. V.T. Chow "Open Chan. Hydr." , pp 360-362]

$$Q = C H^{1.5}, C = 3.27 + \frac{H}{h}, \text{ Pond El.} = \text{Crest El.} + H + h_v$$

Take $h = 3'$, Crest El. 471.0

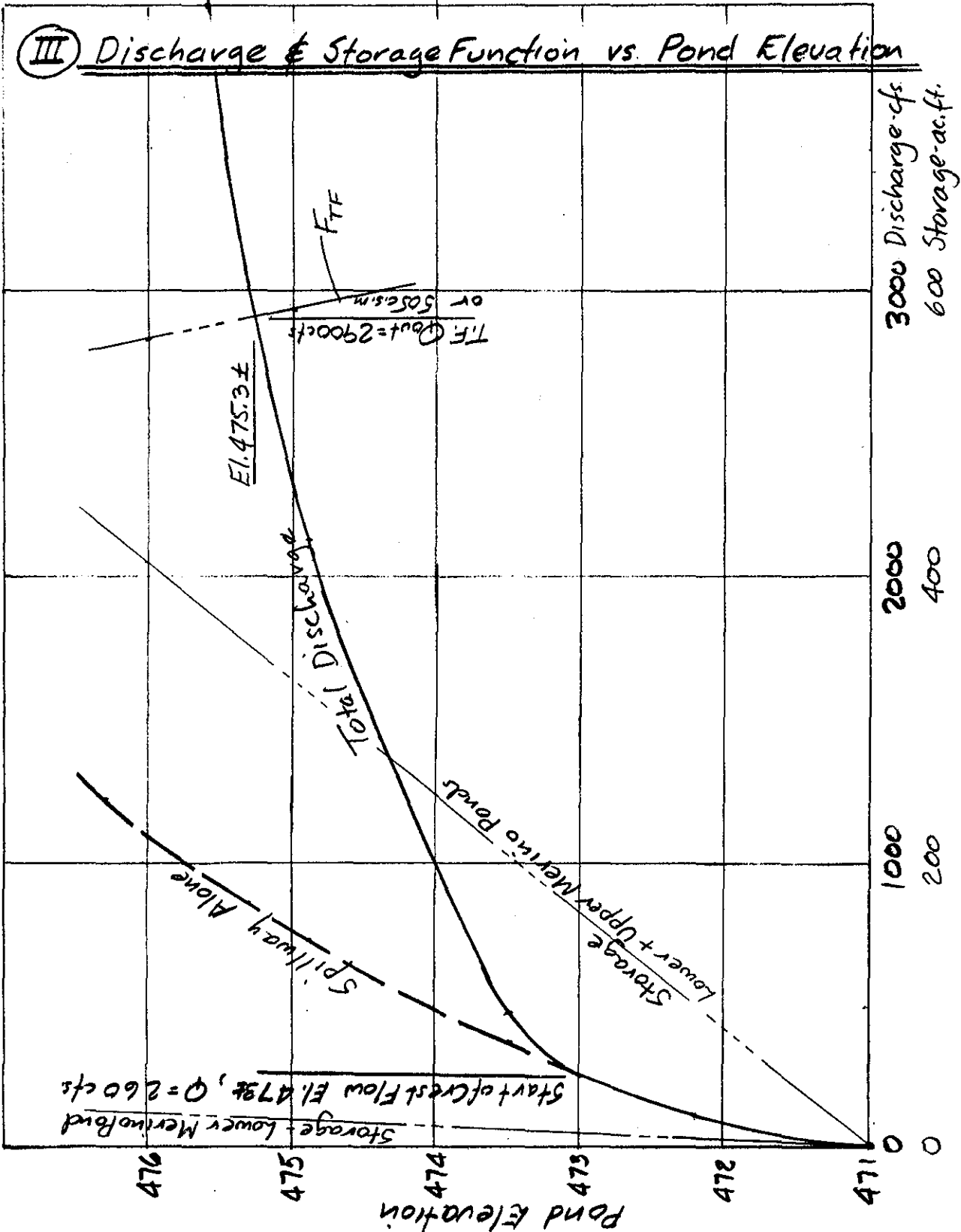
H	C	Q	h_v	Q	Pond El.
1	3.60	3.60	0.20	119	472.2
2	3.93	11.12	0.48	367	473.5
3	4.27	22.19	0.85	732	474.9
4	4.60	36.8	1.31	1214	476.3
5	4.93	55.10	1.89	1818	477.9
6	5.27	77.45	2.59	2556	479.6
3.5	4.44	29.07	1.07	959	475.6

B- Crest Flow

Crest Levels: 110' @ 473, 220' @ 474, 200' @ 474.5 (South Side Dike)

Use $Q = 2.67 H^{1.5}$ [Ref. V.T.C. "Op. Ch. Hydr." pg 53]

Pond El.	110' @ 473	220' @ 474	200' @ 474.5	Tot. Crest Q	Tot. Q
473.5	100	—	—	100	467
474.9	770	500	130	1400	2132
476.3	1760	2050	1290	5100	6314
475.6	1230	1190	620	3040	4000



④ Flow over Crest

A- Test Flood

Pond Elev. 475.3

Lowest Crest 473

$$H = \frac{475.3 - 473}{2.3} = 2.3$$

$$Q = 2.67(2.3)^{1.5} = 9.3 \text{ cfs/ft.}$$

As Critical Flow

$$y_c = \left(\frac{Q^2}{g} \right)^{1/3} = 1.39' ; V_c = 6.7 \text{ fps}$$

⑤ Drawdown Rate

No operational method to draw down the pond is known.

Ⓥ

Failure of Dam

Peak Failure Flow:

Pond Elevation - 473

Toe Elevation - 460 - Approx. Low Pt. In Reservoir

$$Y_0 = 13$$

Dam Length Subject to Breaching = 290

$$W_0 = 40\%(290) = 116$$

$$Q_P = 1.68 W_0 (Y_0)^{1.5} = 1.68 (116) (13)^{1.5} = 9100$$

$$Q_1 = 9100 + 260 = 9360 \text{ cfs}$$

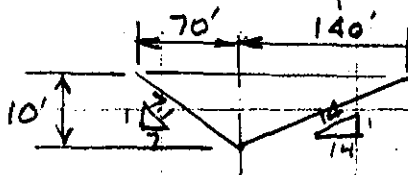
Storage Volume Released:

$$\text{Storage Above Spillway} : 3 \times 0.01 \times 640 = 19.2 \text{ acre ft.}$$

$$\text{Storage Below Spillway} : \frac{1}{3} \times 11 \times 0.01 \times 640 = 23.4 "$$

$$S = \text{Total Storage} = 42.6 "$$

Channel Hydraulics:

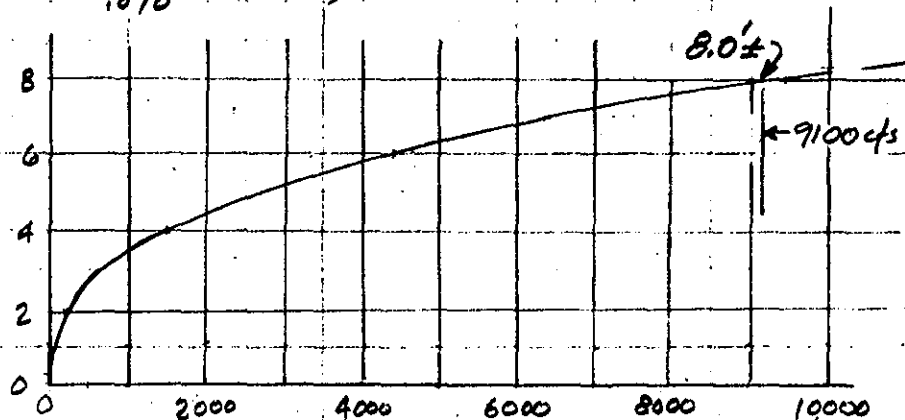


$$S = \frac{21}{300} = .07, \sqrt{S} = .2646; n = 0.070$$

$$A = \frac{1}{2}(7y^2 + 14y) = 10.5y^2; P = 21.1y$$

$$V = \frac{1.49}{0.070} R^{4/3} (.2646) = 5.6 R^{4/3}$$

Y	A	P	V	Q	L _v
2	42	42.2	5.6	234	0.5
4	168	84.4	8.9	1490	1.2
6	378	126.6	11.6	4396	2.1
8	672	168.8	14.1	9450	3.1
9	850	189.9	15.2	12900	3.6



Note: Channel is too short between dam & occupied structures to allow any channel attenuation of initial surge wave
Failure causes T.W. to increase from 2' to 8' ±; Δy = 6'

Time to Drain:

$$\frac{43560 (42.6)}{3600 (\frac{1}{2}) (9100)} = 0.11 \text{ Hours, or 6.8 Minutes to drain}$$

APPENDIX E
INFORMATION AS CONTAINED
IN THE NATIONAL INVENTORY
OF DAMS

LOWER MERINO POND DAM